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ABSTRACT

There is every reason to believe productivity per person in education has decreased over the years. Per pupil expenditures have increased nearly threefold in constant dollars over the past two decades, while student/teacher ratios have decreased. Those who doubt that per person productivity can be increased do so because of their conviction that there is no substitute in education for a low student/teacher ratio. Many of those who press for an increase in productivity build their hopes for such achievement on the potential of new tools such as television and computer assisted instruction. However, the problem is a cultural one. The attitudes requisite for constant improvement of productivity per person must be built into the culture in which the individuals work. Just as the profit motive in private enterprise has biased the entire sector to high and increasing productivity per person, the low student/teacher ratio goal in education has biased the entire field toward decreasing productivity. Research and Development efforts in the field of student-centered instruction hold the promise of increasing per person productivity in education, as do multi-unit school models, and should be whole-heartedly supported. (HMD)

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R&D AND PRODUCTIVITY IN EDUCATION

Address by Patrick E. Haggerty
Chairman, Texas Instruments Incorporated

before the American Educational Research Association
April 18, 1974

Most of us tend to associate the impact of higher productivities per person with the ability of the consumer to purchase more goods for relatively less money while at the same time the worker producing the goods truly can earn more. These are important consequences, but of at least equal significance has been the freeing of resources previously required for the production of food and other material goods so that they might be applied to improving health care or education or other desired services.

As recently as 200 years ago, 90 percent or more of any community had to be engaged in producing food. This left only a handful of men and women to be governors, craftsmen, merchants, scholars, artists, teachers, doctors.

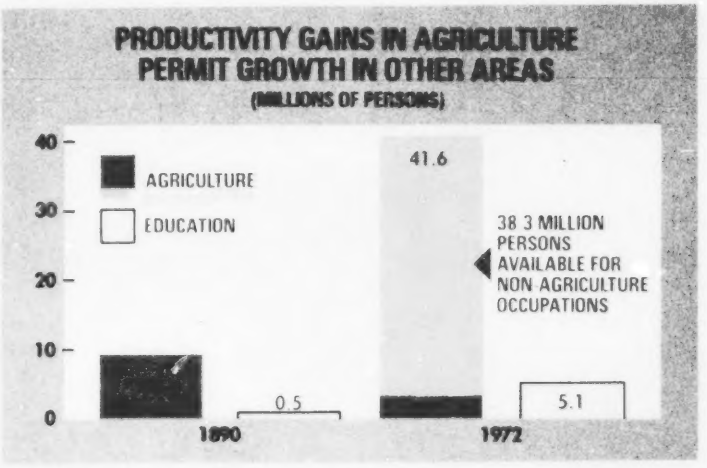

Figure 1 [1]

Here in the United States in 1890 we still had an estimated 9.4 million people in agriculture to produce the food and the other raw agricultural products

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needed by a population of 63 million. Yet, in 1972, only 3.3 million workers were required to produce agricultural products for a population of 209 million. Had we been producing in 1972 as we were in 1890, it would have taken 41.6 million workers to produce the quantity of agricultural products consumed and exported in 1972. Thus, more than 38 million workers were released to man our factories and produce our industrial goods, but especially to move into the service areas, including health, government, and education.

In 1890, we had only about 500,000 workers in education, so there were 19 times as many workers in agriculture as in education. Since we had 5.1 million adults in education in 1972, in a very real sense, more than 4.5 million of the workers released because of the increasing productivity in agriculture were released to go into education, and in 1972 there were more than 1.5 times as many workers in education as there were in all of agriculture.

As contrasted with the gains in agriculture and industry, there is every reason to believe that, in the overall, productivity per person in education has decreased.

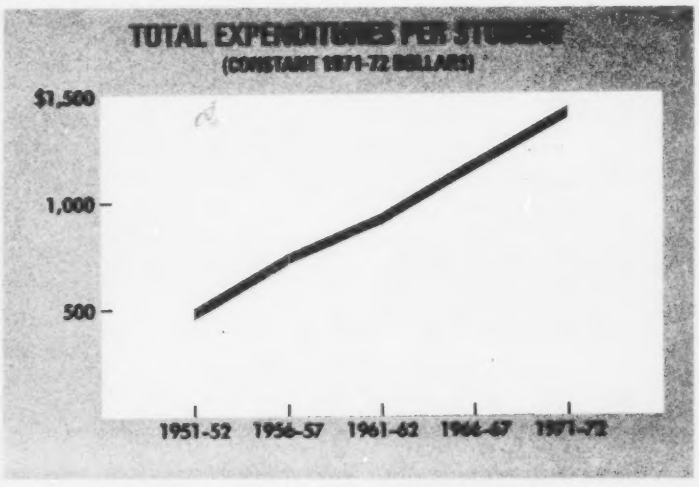

Figure 2[2]

Our expenditures per student have gone in constant 1971-72 dollars from $481 per student in 1951-52 to $1421 in 1971-72. Therefore, in 1971-72 we spent nearly three times more per student in constant dollars than we did 20 years earlier.

All of us know, of course, that it is extraordinarily difficult to measure productivity in education with any accuracy and that this comparison of cost changes per student with time is an oversimplification, but I don't think there is anyone in the field who believes that productivity per adult engaged in education is anything like three times what it was in the Early Fifties. Since that is what has happened to costs per student, the necessary conclusion follows that productivity per person in education has decreased.

In 1890 or probably even 30 or 40 years after that, when the total number of adults engaged in education was relatively small, the fact that productivity in education was not increasing was not terribly important. In a very real sense, the productivity gains in agriculture and industry were so large and the number of workers in them so many by comparison to the few in education that the men and women in industry and agriculture literally could carry on their backs the added costs to society occasioned by the failure to increase productivity in education. In terms of the total resources of society, the extra burden simply wasn't significant. That is no longer true. The nearly $86 billion we spent in support of regular educational institutions in school year 1971-72 represents nearly 8 percent of our gross national product, and the 5.1 million adults in education were 6 percent of our total working population. It may be

unpalatable to those in education, but they have been dependent for any real gains in their own pay upon the increasing productivity of the other sectors of the economy, and only to the extent that education has contributed to that increasing productivity have those who make their living in education earned th ir increased compensation.

Nor does this tell the whole story. In 1951 the United States had a total population of 156 million. There were over 1,800,000 adults in instructional administration and approaching 37 million students enrolled in regular public and non-public institutions from kindergarten through postgraduate in that school year. This means that in that school year, 1951-52, just under 25 percent of our total population had made education their major time commitment. By 1972, with more than 5 million adults and 60 million students, over 31 percent of our total population were so committed. Not only are its high purposes still of overriding importance to both our cultural and material development, but education has become so pervasive, indeed the major commitment of nearly a third of our people, that it is imperative that we learn how to improve the overall productivity of our total educational establishment.

This observation is hardly very novel. It has been made by many both within and without education over the past decade. Most who doubt that it will be possible to improve the productivity per person in education at any kind of adequate rate usually do so because of their conviction that there is no substitute in education for a low student/adult ratio, and hence no way out of the ever-increasing costs with educational wages inevitably pressed up by the increases in the rest of society.

Similarly, many who press for improving productivity per person build their hopes for such achievement on the potential availability of such new tools as television and computer-aided instruction, and they urge the organizational and institutional changes they see as necessary before such new tools can become effective.

I am personally certain that those who doubt our ability to improve productivity per person in education significantly are wrong, but I am about equally convinced that those who are confident that all that is required is widespread adoption of these new tools are also wrong.

Fundamentally, I believe the problem is a cultural one. The attitudes requisite to constantly improving productivity per person must be built into the culture in which the individuals work. Those who are responsible must approach their responsibilities in a way which takes for granted that more resources, either for their work or as personal financial rewards for doing it, can come only because more is accomplished per person this year than last year and that next year still more per person must be done.

Every long-lasting institution evolves a culture of its own, and Texas Instruments, the organization to which I have devoted most of my professional life, is no exception. Our culture is determined by our policies, procedures, and practices as they are formally stated and installed as systems and as they actually are perceived and executed by the individuals who make up Texas Instruments. These policies, procedures, and practices--and the culture they produce--all are aimed at creating, making, and marketing products and services to satisfy the needs of our customers around the world and are keyed to the incentive provided by the profits we make.

The system forces us to recognize increasing costs, either by increasing prices or improving productivity per person, or both. Competition on a world-wide basis severely limits our ability to increase prices. In fact, in sectors of our business totaling about half our annual volume, we have had average price decreases over the past two decades of about 15 percent per year. We have been forced to learn how to use science and technology, capital and management, to improve our productivities per person and reduce our overall costs.

The relatively automatic operation of the market economy creates a culture common to all private enterprise, a culture that is dependent upon and oriented toward the need to provide products and services for customers at a profit. It is a culture in the full sense of the word, one that automatically biases the entire sector toward high and increasing productivities per person, and it does not exist in the not-for-profit sector.

I have not used this illustration as a pitch for our mixed-market economy or to suggest that our educational system should be in the profit sector, although I do think a very considerable part of it could be and would operate in an improved fashion if it were. What I am trying to convey is that just as the market and its profit system automatically generate a culture which is biased toward constantly increasing productivities per person, so also some equally effective change in educational culture will have to be generated if it, too, is to become biased toward constantly increasing productivities per person. No simple addition of tools and technology will accomplish this shift. Those who believe so are being fooled by the apparent ease with which tools and technology accomplish improvements in productivity in the private, profit-making

sector, where the cultural bias of the system seeks them out, and there is a constant and pervasive pressure toward increasing productivities per person.

Within education, on the other hand, the culture imposes a bias in exactly the opposite direction. To oversimplify only a little, our entire educational system is a complex of teachers, each surrounded by a small circle--and the smaller the better--of students to whom the teacher is imparting his or her knowledge of the specific subject matter of the course plus a considerable addition of general wisdom. The administrative structure is tolerated as a necessary nuisance to support the complex of the small teacher-centered circles. Thus, even though teachers have long recognized that every student is an individual, the overall culture and the system it engenders are teacher-centered.

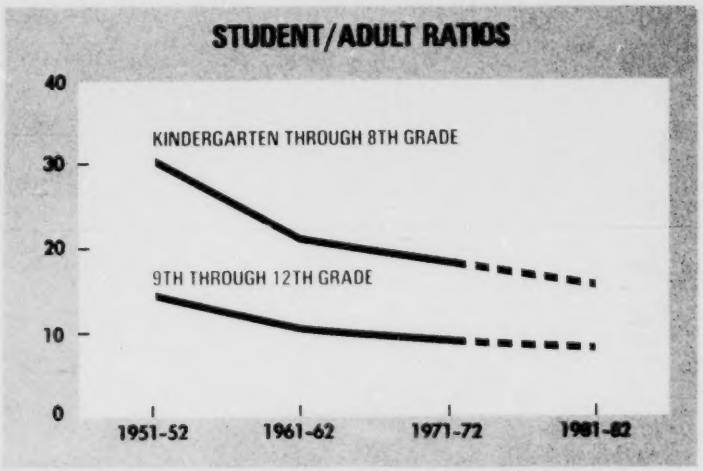

Figure 3[3]

The cultural bias in education toward ever-decreasing student/adult ratios has been just as effective in its way as has the opposite bias toward ever-increasing productivities per person in the market sector. Note the upper curve

showing the ratio from kindergarten through eighth grade, with the ratio decreasing from 30.7 in 1951-52 to 21.7 in 1961-62, down to 18.2 in 1971-72. Further, HEW projects a still lower ratio of 16.2 in 1981-82.

Similarly, for the high school years, the ratio has decreased from 14.9 in 1951-52 to 10.5 in 1961-62, 9.7 in 1971-72, and is projected to go on down to 9.4 in 1981-82.

As another very specific illustration, here is a statement from the Operations Goals for 1972-73 of the Dallas Independent School District:

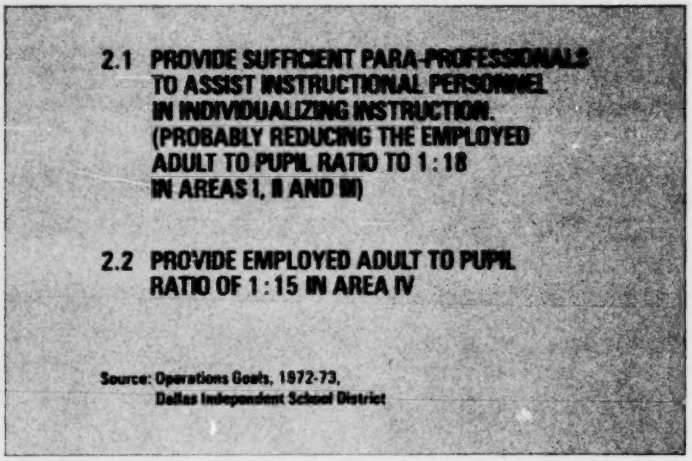
2.1 PROVIDE SUFFICIENT PARA-PROFESSIONALS TO ASSIST INSTRUCTIONAL PERSONNEL IN INDIVIDUALIZING INSTRUCTION. (PROBABLY REDUCING THE EMPLOYED ADULT TO PUPIL RATIO TO 1:18 IN AREAS I, II AND III)
2.2 PROVIDE EMPLOYED ADULT TO PUPIL RATIO OF 1:15 IN AREA IV
Source: Operations Goals, 1972-73, Dallas Independent School District

Figure 4

Since the ratio of pupils to adults for the year 1971-72 was 19.5, the trend is clearly toward increasing costs and decreasing productivity per person. The superintendent of the Dallas Independent School District is Dr. Nolan Estes, a man for whom I have enormous respect. He has to be one of the most competent school superintendents in the entire nation--dedicated, innovative, and energetic. I have great confidence in his judgment, and I have no doubt whatsoever

that that goal is there because Dr. Estes and the administrators and the teachers who shared with him the responsibility for setting it firmly believe that a reduced student/adult ratio is essential to improve the effectiveness of education for the student. Nor do I doubt that they are right, so long as we operate within a cultural system which is fundamentally teacher-centered.

Thus, the teacher-centered culture is very pervasive in its bias toward decreasing student/adult ratios, and so long as the primary mechanism for attaining educational objectives is seen as ever lower ratios, the culture must retain the bias, and additions of tools and technology are likely to be peripheral at best in their impact. If indeed this teacher-centering is the only effective way to achieve educational goals, then it is going to be extraordinarily difficult to attain the increased productivities per person which seem essential if the total resources required are not to become astronomical.

Some of our most able and dedicated educators truly believe that education is caught on the horns of a dilemma with the only route to fulfillment of adequate educational goals blocked by the need for constantly increasing resources and society's ability and willingness to provide them. I do not believe this pessimism is justified, and I think one can see a different culture developing in education which need not include this bias toward ever-decreasing student/adult ratios and which by its very nature is susceptible to adding the concepts required if constantly increasing productivities are to be attained.

This different culture, which I would describe as student-centered instead of teacher-centered, is not something new and foreign to the field of education. It goes back at least to 1919 and the Winnetka, Illinois, plan with self-pacing and mastery demonstration as principles of instruction. Self-pacing and

required demonstration of mastery of subject matter before proceeding to the next unit of study are being used at an increasing rate in teaching college-level science. Kulik, Kulik, and Carmichael discuss a number of such programs and their apparent effectiveness in the February 1, 1974, issue of Science.[4]

At the elementary school level, the University of Pittsburgh's Learning Research and Development Center considers that one of its significant research results is what it calls Individually Prescribed Instruction. IPI stresses as its major objective the ability of each student to work at his own rate through units of study in a learning sequence and the development in each student of a demonstrable degree of mastery flowing from self-paced and self-directed effort. Research for Better Schools, Inc., in Philadelphia has collaborated with the Learning Research and Development Center to involve nearly 90,000 elementary school children in one or more of these IPI programs.

Another effort at the elementary school level is Individually-Guided Education (IGE) in a model developed by the Wisconsin Research and Development Center for Cognitive Learning with the Institute for the Development of Educational Activities (IDEA) also contributing. In this current school year there are about 1700 elementary schools in 37 states using this IGE model. Since there were only 7 such schools, all in Wisconsin, as recently as 1967-68, this cultural shift to student-centering is clearly growing at a high rate.

These illustrations are just some of the efforts around the nation to shift from teacher-centering to student-centering.

One of the most stimulating and challenging discussions of individually paced, mastery-oriented teaching is Fred Keller's 1967 Presidential address to the American Psychological Association, which he called "Good-bye, Teacher."

In his address, Dr. Keller summarized the following features of this teaching method which he felt distinguished it most clearly from conventional teaching procedures:

> "1. The go-at-your-own-pace feature, which permits a student to move through the course at a speed commensurate with his ability and other demands upon his time.
>
> "2. The unit-perfection requirement for advance, which lets the student go ahead to new material only after demonstrating mastery of that which preceded.
>
> "3. The use of lectures and demonstrations as vehicles of motivation, rather than sources of critical information.
>
> "4. The related stress upon the written word in teacher-student communication; and, finally:
>
> "5. The use of proctors, which permits repeated testing, immediate scoring, almost unavoidable tutoring, and a marked enhancement of the personal-social aspect of the educational process."[5]

Earlier, I identified this new educational culture as student-centered. In his address, Dr. Keller describes the difference between teacher-centering and student-centering:

> "In systems like these, and in the one I have centered on, the work of a teacher is at variance with that which has predominated in our time. His public appearances as classroom entertainer, expositor, critic, and debater, no longer seem important. His principal job, as Frank Finger (1962) once defined it, is truly 'the facilitation of learning in others.' He becomes an educational engineer, a contingency manager, with the responsibility of serving the great majority, rather than the small minority, of young men and women who come to him for schooling in the area of his competence."[6]

I would like to emphasize that while the shift from teacher-centering to student-centering is indeed a complete cultural shift, it does not automatically provide the emphasis on increasing productivity per adult that seems a necessity.

Indeed, although there does seem to be considerable evidence that results with students are superior, many of the IPI and IGE programs are at least as prodigal in the use of adult manpower as any teacher-centered program. On the other hand, in a student-centered culture, adding the requirement for constantly increasing productivity per adult does not generate any conflict in fundamental purpose as it inevitably does within the teacher-centered culture.

The Wisconsin R&D Center's multi-unit school model illustrates what I mean. There, as most of you know, the traditional, self-contained classrooms are replaced with larger, non-graded units. In each unit a unit teacher, two or three staff teachers, a first-year teacher, a teacher aide, an instructional secretary, and an intern work with 100 to 150 students in a three- or four-year age span. Unit leaders and building principal make up an instructional improvement committee and cooperatively define the school's educational goals. At the district level, a system-wide policy committee--which includes central office administrators and consultants, principals, and representative unit leaders and teachers--develops policy guidelines and coordinates the use of human and physical resources. Even though this Individually-Guided Education model does not include productivity goals as a part of its structure, and although early costs with innovative approaches are unfortunately usually high, a study of 39 of these multi-unit elementary schools in 8 states showed little or no increase in costs per student, including expenditures involved for instructional materials and equipment.[7]

In a multi-unit, student-centered school system, productivity goals can and should be set for the whole system rather than just for individual grades or for individual schools. Manpower and other resources of the entire system can be pooled to achieve the overall student/adult ratios necessary to assure increasing

productivities. Student/adult ratios can vary widely as may be necessary or demanded by the subject matter or the students to achieve the learning objectives sought so long as the overall goals are met. The entire school system can be so oriented as to develop in the individual student a growing ability from his earliest years in school to self-initiate, self-pace, and self-rely. If this calls for even lower student/adult ratios in the earlier years than we are using now, all well and good, if this increase is counterbalanced by higher ratios in the later years. If some students require more help and lower student/adult ratios, this need not affect overall productivity per person so long as these lower ratios are balanced by higher ratios among students requiring less adult help.

Tools and technology, instead of being simply grafted on a teacher-centered system not well suited to use them, can be adapted or designed to meet the needs of the learning and productivity goals established. TV classrooms at scattered locations conducted in conjunction with live classrooms, computer-aided instruction, audio and TV cassettes--and new combinations, new tools, and new technologies not yet thought of--all can be applied as necessary to meet the needs of the individual and the productivity goals of the school system. But so can books and correspondence courses designed to meet the learning goals and the students' needs adequately. We already know that many of the new tools and technologies, such as computer-aided instruction and audio and television cassettes, lend themselves especially well to individualized, self-paced instruction.

An educational system with a student-centered culture can be far less structured in its institutional responses than our present system. For example, with an entire school system organized on this basis, there would no longer be

any need for the present school year and summer vacation pattern. Students and adults alike could fit in vacation time much more flexibly throughout the year as met their own needs and desires satisfactorily and learning and productivity objectives established were achieved.

Obviously, I do not believe this shift to a student-centered educational culture can be considered properly implemented until it consistently includes productivity goals as well as educational goals. I certainly would hope that one of our R&D laboratories concentrating on student-centering, such as the Wisconsin Research and Development Center for Cognitive Learning, will expand its R&D efforts to include work on improving individual productivities so that these conceptions can be developed to the point where they become a built-in part of the entire approach.

Figure 5 illustrates the kind of productivity gains which would be really meaningful. Of course, the desired student/adult ratios must be attained school system by school system and as established to meet the needs of that particular system, but in my examples, I will work from the overall national ratios.

POTENTIAL CHANGE IN STUDENT/ADULT RATIOS WITH A 3% ANNUAL GAIN IN PRODUCTIVITY PER ADULT

	ACTUAL 1971-'72	POTENTIAL 1981-'82
KINDERGARTEN THROUGH 8TH GRADE	18.2	24.5
9TH THROUGH 12TH GRADE	9.7	13.0
HIGHER EDUCATION	6.1	8.2

Figure 5[8]

The actual student/adult ratios in 1971-72 were 18.2 for the elementary level, 9.7 for high school, and 6.1 for higher education. For decades, in manufacturing industry, average gains in productivity per person per year of about 3 percent have been attained. Agriculture has been running considerably higher than that, 5 percent or more per person per year. But certainly a 3 percent gain per person per year in productivity would represent a very significant accomplishment for education. If we could assume that over the ten years following 1971-72 we could have taken steps to achieve that 3 percent gain in productivity per person per year, while still meeting our educational goals, the student/adult ratio in 1981-82 would be 24.5 for the elementary level, 13 for high school, and 8.2 in higher education.

These are not by any means impossible goals, as illustrated most graphically by comparing them with the ratios I presented earlier for kindergarten through eighth grade and for high school. The 24.5 ratio for the elementary schools in 1981-82, for example, is well below the 31.1 ratio which existed in 1951-52, and the productivity goal of 13 for high school is below the nearly 15 which prevailed there in 1951-52.

Yet, it is gains in productivity per person per year of this magnitude that we should be seeking, and the R&D being conducted on student-centered systems should be searching for approaches which will allow these kinds of productivity goals to be established and attained along with the educational goals. (I should add that I am oversimplifying in talking about productivity exclusively in terms of student/adult ratios. Obviously, one must be concerned as well about the other costs involved, and if these improved student/adult ratios are attained by increasing facility, equipment, and supplies costs unduly, no overall reductions in costs will result.)

In beginning this discussion, I emphasized that I thought one of the most important consequences of improving productivity per person was the human resources made available to society. Now I know that to many, looking at it in the shorter perspective, it looks instead like putting people out of work. Yet, it should be clear from the agricultural example I gave earlier that, in fact, in an active, economically dynamic society such as ours, what really happens is that those resources are made available to do something else of more significance in the society.

POTENTIAL CHANGE IN NUMBER OF ADULTS IN EDUCATION WITH A 3% ANNUAL GAIN IN PRODUCTIVITY PER ADULT
(THOUSANDS OF PERSONS)

	ACTUAL 1971-'72	POTENTIAL 1981-'82	CHANGE
KINDERGARTEN THROUGH 8TH GRADE	1992	1449	−543
9TH THROUGH 12TH GRADE	1555	1100	−455
HIGHER EDUCATION	1460	1528	+ 68

Figure 6[9]

Here is what this kind of modest gain in productivity per year would make available in ten years, assuming the total number of students in each of the three categories projected for 1981-82 by the Department of Health, Education and Welfare.

There would be 543,000 fewer adults in elementary schools, 455,000 fewer in high school, and only 68,000 more in higher education, in spite of an increase in enrollment of more than 2.5 million. Thus, across education as a whole, more than 900,000 highly qualified men and women would be made available to society to take on other tasks.

Obviously, we are not going to have this kind of opportunity in 1981-82 because the overall cultural shift to student-centering is only beginning, and it will take many years to penetrate all of education. I wish we were going to have it, because I am convinced that when our whole educational culture is student-centered, there are going to be two very important consequences:

1. The adult citizens it produces, accustomed from their elementary school years through higher education to self-initiated, self-paced education and its relative freedoms from the limitations of rigid schedules and fixed geographical locations, will have developed to a far greater extent than at present both the desire and ability to continue organized study and learning throughout their entire lives.
2. We will have in place in the United States a highly flexible educational system, with the flexibility increasing with level and freed in the most part from the rigidities of fixed class schedules and specific school locations. It will be perfectly feasible to mix work and education in almost any combination which meets the individual's needs both from a time and subject matter standpoint. Many students will begin mixing regular jobs and continuing study by their early high school years. Most will in college. The rate of change and increasing complexity of our society will require adaptation and continued learning from all of us, and the convenience and ready and broad availability of self-initiated and self-paced study will make it customary for most adults to continue this kind of formal education throughout their entire lives. Presumably, the principal impetus will be the demand of their own career progressions, but wise development of the overall system will ensure that the opportunity for continued cultural development is equally available and sought after.

Present reproduction rates in the United States suggest that our population is likely to stabilize not too far from the 250 million level, perhaps in another 40 to 50 years. With this kind of student-centered learning system in place, I think the likelihood is very high that instead of 30 percent of our total population being involved in formal education, three-quarters of them will be. None of this will be possible until we find ways of freeing resources to allow it. We are going to need those 900,000 adults and the resources they represent, and that is why I wish we were going to face the problem and the opportunity that the higher student/adult ratios I projected as goals would generate.

There is in the nation, and specifically in our Congress, a great deal of justifiable concern at the apparent ineffectiveness of much of the research and development in education. Indeed, it does not take too much examination of the R&D efforts in education of this past decade or so to conclude that there has been much waste and that too much of the effort has been unproductive. That being the case, one of my principal preoccupations since becoming Chairman of the National Council on Educational Research on its initiation last July has been to ask those who have participated in educational R&D to give examples of demonstratedly successful consequences from R&D, including the evaluation data which justify the judgment that these are successful efforts.

Incidentally, I want to hasten to emphasize that the judgments I express are entirely my own; in no sense, am I speaking for the National Institute of Education or the National Council on Educational Research. To me, while some of the examples given do indeed represent good work with high potential for affecting education positively, in the overall, the responses have been singularly unsatisfying and not very helpful in convincing the skeptic that past research and development in education has been worthwhile, or even more important, that it justifies continued and enlarged financial support in the future. Even those most enthusiastic about the probable impact of IPI or IGE

have, it seems to me, tended to emphasize the more immediate and narrowly based consequences of these efforts. Yet, I am convinced that the overall eventual impact of the research and development bringing about this shift in our educational culture from teacher-centering to student-centering is of overwhelming importance and that its consequences will be of exactly that far-reaching and constructive kind that one hopes for and which occasionally results from R&D. If so, then, these consequences alone are more than sufficient to justify many times over the total resources committed thus far to the entire educational research and development effort. It is true that for the kind of revolutionary consequences I envision to develop, a more coherent pattern of student-centering must evolve, extending from kindergarten completely through higher education, productivity goals must be included normally and routinely along with the other important educational goals, and we must succeed in developing the kind of lifelong education patterns I anticipate.

But, in turn, these are exactly the important effects that student-centering makes possible and are in themselves areas where fruitful additional research and development can and should be conducted. The researchers involved do have to develop a clearer and more coherent vision of what is sought, and the overall effort needs to be broadened and coordinated so that the total potential of the shift may be realized, but no one working in this field need be diffident as to the significance of his effort.

I suggest that not only is the research and development producing the student-centering of major significance to education, but it is one of the most important efforts in research and development in any field now being conducted. Further, I am convinced it will succeed.

R&D AND PRODUCTIVITY IN EDUCATION

References

1. a. Agriculture data developed from:
   (1) 1890 - Economic Growth in the United States. New York: Committee for Economic Development, October 1969.
   (2) 1972 - Survey of Current Business, U.S. Dept. of Commerce, Bureau of Economic Analysis, July 1973, p. 42, Table 6.6.

   b. Education data developed from National Center for Educational Statistics, U. S. Department of Health, Education and Welfare, Office of Education:
   (1) 1890 - Biennial Survey of Education, 1950-52
   (2) 1972 - Projections of Educational Statistics to 1981-82, Tables 27 & 31, together with:
      (a) Statistics of State School Systems, 1963-70 related issues, pp. 3-4.
      (b) Numbers and Characteristics of Employees in Institutions of Higher Education, 1966-67 related issues.

2. Data developed from same sources as Ref. 1b(2).

3. Ibid.

4. Kulik, Kulik, and Carmichael, "The Keller Plan in Science Teaching," Science Magazine, Vol. 183, 1 Feb. 1974, p. 379.

5. Keller, Fred S., "Good-Bye, Teacher...", Journal of Applied Behavior Analysis 1968, 1, p. 83. (c) 1974 by the Society for the Experimental Analysis of Behavior, Inc.

6. Ibid., p. 88.

7. "Promoting Change in Schools: A Diffusion Casebook," Far West Laboratory for Educational Research and Development, Draft, October 1973.

8. 1971-72 data developed from same sources as Ref. 1b(2).
   1981-82 data developed by TI Advanced Economic Planning Department.

9. 1971-72 data developed from same sources as Ref. 1b(2).
   1981-82 data developed by TI Advanced Economic Planning Department and Projections of Educational Statistics to 1981-82, 1972 edition.